INTEPRO SYSTEMS

Intepro Systems

PEL Series

Regenerative AC Load Bank

User Manual

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Version 1

Version History

Version No.	Release date	Writer	Description	Hardware version applied
V1.0	4-2015		Rev 1	

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Safety Precautions

Danger

Beware of the high temperature of this equipment. **DO NOT <u>open the chassis without technician present or authorization from Intepro Systems</u>**.

- When the PEL needs to be moved or rewired, please shut down the instrument completely by disconnecting the input power lines and wait at least 20 minutes for the capacitors in the instrument to discharge to prevent electric shock.
- In order to ensure the personal safety of users, this series of power products must be grounded before use.
- In case of fire, please use dry powder fire extinguishers instead of liquid fire extinguishers to avoid the risk of electric shock.
- Liquid or other foreign objects must not be allowed to enter the cabinet of the grid simulator.

Attention

The application environment and storage methods affect the service life and reliability of the product. Extended use in the following conditions should be avoided:

- Ambient high or low temperatures or humidity beyond technical specifications (temperature: -20℃to 40℃; relative humidity: 5% to 95%);
- In direct sunlight or exposed to heat sources;
- Places susceptible to vibration or collision;
- Environments with dust, corrosive substances, salt and combustible gases;

Keep the air inlets and outlets unblocked to promote ventilation to avoid a rise in the internal temperature, which may shorten the service life of components, and affect the service life of the product;

Grid simulators not in service for a long time should be stored in a dry environment. The temperature range for storage is -40℃to 70℃.

To properly protect the equipment, only the personnel of Intepro Systems are allowed to open the front door or side cover. If the quality assurance seal is broken, required services will incur charges and guaranty is void.

Danger: conditions that may cause serious equipment damages or human casualties.

Attention: Conditions that may cause moderate injuries or damages to equipment.

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1 Introduction

PEL series regenerative AC load bank is a new generation of bi-directional AC load bank. PEL employs the most advanced PWM rectification (active rectification) technology with four-quadrant operation capability and digital signal processor technology (DSP). It is not only able to simulate different load characteristics including resistance and inductive load, but also feed the energy that helps the industry to save energy and reduce carbon emissions. All necessary protection mechanisms are implemented in the electronic circuitry to quickly detect, execute proper actions immediately and activate necessary alarms. Those protections include overload, over-current, over-voltage and short circuit protection. Laminated bus-bar technology used on the DC bus combined with high efficient IGBT modules further increase the reliability and stability of the machine. This machine can be controlled by either the touch panel installed on it (the local control) or by the communication channels (e.g. RS485) connected to an external computer (the remote control). Either way of control has a user friendly interface which makes the users in controlling and programming this machine much easier than before.

The main characteristics of PEL Series Regenerative AC Load Bank are listed as follows:

1) Providing three working modes including constant current, constant resistance and constant power mode, simulating linear load characteristics of power factor 0.3~1.0 (lead/ lag);
2) Adjustable parameters including PF, current, power, resistance and etc.;
3) Suitable for single phase or three phase electric devices burn-in test with supporting 100% unbalance load condition;
4) Energy feeding efficiency to the power grid up to 90%;
5) High power factor in grid connected side up to 0.99;
6) Low current THD in grid connected side (lower than 4%) with low harmonic pollution for grid utility;
7) PEL is expandable for larger capacity for future expansion by parallel connecting multiple units;
8) Standard Modbus protocol and communication interface RS485 are helpful for remote control;
9) 7” Touch panel user friendly interface;
10) Event history records 255 operation events;
11) The laminated busbar structure is used to effectively reduce the inductance of the inverter circuit and improve the reliability of the inverter;
12) Module design is convenient for installation, maintenance and usage;
13) Speed-adjustable fan with lower noise and extended service life;

2 Specifications

2.1 Specifications Table

Model		PEL-33060	
Input	Input voltage	120V/208V, 220V/380V, or 277V/480V+/-10%	
	Input frequency	47Hz～63Hz	
	Phase / wire	3-phase 4-line +G or 1-phase 2-line+G	
	Input current	120V/208V: 166A (Maximum) 220V/380V: 90A (Maximum) 277V/480V: 72A (Maximum)	
	Input THD	≤4%	
	Power factor	0.3～1.0 (lead/lag) (current≤15A,PF=1)	
Working mode	Constant current (CC)	0～90A(single-phase),PF;0.3～1.0 (lead/lag) (current≤15A, PF=1)	
	Constant Resistor (CR)	2.4～44Ω(single-phase),PF;0.3～1.0 (lead/lag) (current≤15A, PF=1)	
	Constant power (CP)	0～20kVA(single-phase),PF;0.3～1.0 (lead/lag) (current≤15A, PF=1)	
Grid Connected Side	Grid connect voltage	120V/208V, 220V/380V, or 277V/480V+/-10%	
	Grid connect frequency	47Hz～63Hz	
	Grid connect current	120V/208V: 166A (Maximum) 220V/380V: 90A (Maximum) 277V/480V: 72A (Maximum)	
	Grid connect iTHD	≤4%	
	Grid connect power factor	≥0.99	
	Grid connect efficiency	≥90%	
Protection		Protection for under-voltage, under-frequency, over-current, IGBT over-current, over-thermal or emergency shut-down	
Operation and display of touch panel	Input voltage	Accuracy: 0.2V+0.1％FS	Resolution: 0.1V
	Input frequency	Accuracy: 0.01Hz +0.01％	Resolution: 0.01Hz
	Input current	Accuracy: 0.2A+0.1％FS	Resolution: 0.1A
	Input power factor	Accuracy: ±0.01	Resolution: 0.01(count)
	Input power (kW)	Accuracy: 0.2kW +0.1％FS	Resolution: 0.1kW
	Grid connect voltage	Accuracy: 0.2V+0.1％FS	Resolution: 0.1V
	Grid connect frequency	Accuracy: 0.01Hz +0.01％	Resolution: 0.01Hz
	Grid connect current	Accuracy: 0.2A+0.1％FS	Resolution: 0.1A
	Grid connect PF	Accuracy: ±0.01	Resolution: 0.01(count)
	Grid connect power	Accuracy: 0.2kW +0.1％FS	Resolution: 0.1kW
	Consumed electricity	Accuracy: 0.2kWh +0.1％FS	Resolution: 1kWh(count)

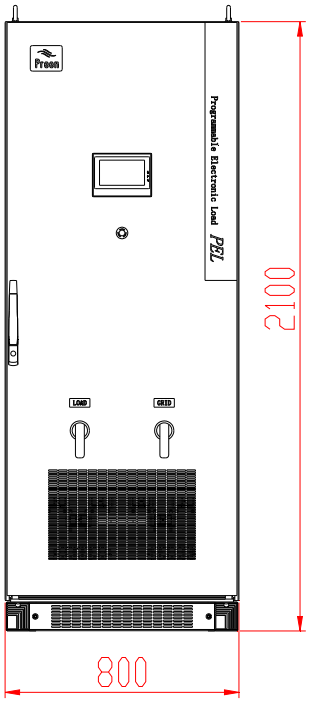
	Efficiency	Accuracy: 0.5+0.5%FS	Resolution: 1%(count)
Environment		Humidity during storage: 90%; working temperature: 0℃~45℃	
Cooling method		Forced cooling with speed-adjustable fan	
Dimension W*D*H (in / mm)		31.5 x 31.5 x 82.68 / 800 x 800 x 2100	
Weight (lb / kg)		1675.5 / 760	

2.2 Physical Dimensions

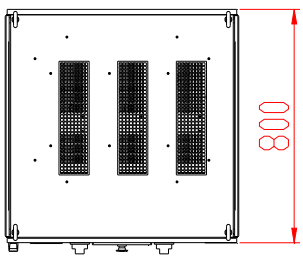
The dimensions of the PEL series product is in proportion to its capacity. The actual figures of this machine are：

Table 2-1 Dimensions list

Capacity (kVA)	Physical dimensions		
	Width(mm)	Depth (mm)	Height (mm)
60	800	800	2100



(a) Front view



(b) Top view

Figure 2-1 Physical body

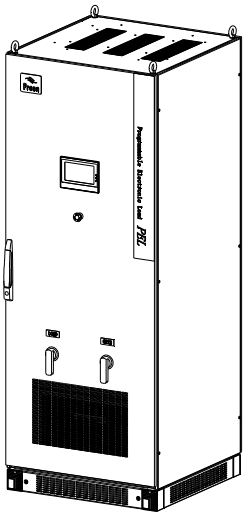


Fig2-2 Side view of the whole machine

2.3 Illustration of outline

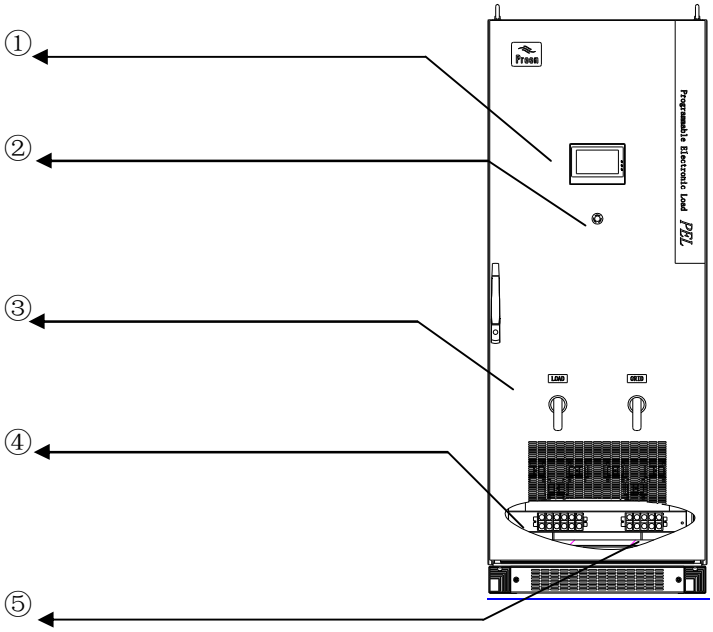


Fig2-3 Figure of outline illustration

① Touch panel;

② Emergency stop;

③ Circuit breaker on load side (left side), circuit breaker on grid connected side (right side);

④ Copper bar on load side (they are A, N1, B, N2, C, N3 respectively from left to right), while G is on baseboard;

⑤ Copper bar on grid connected side (they are U, V, W, N respectively from left to right), while G is on baseboard;

3 Transportation and Installation

3.1 Notes on transportation:

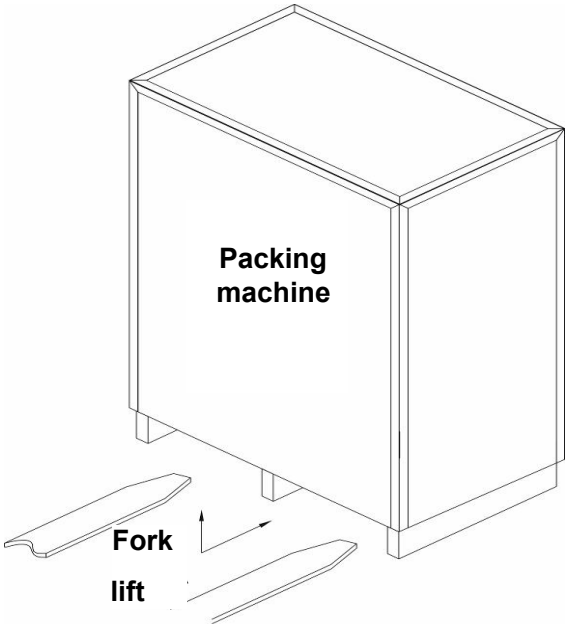


Fig 3-1 Moving with forklift

There is space left in the bottom of the cabinet of PEL-33060 that can be used for moving the cabinet with a forklift. Once the cabinet / packing is removed this machine is able to move with its own wheels independently.

Because of the heavy weight of this machine, please use a forklift to move the cabinet slowly and with special care. Try to avoid any collisions with other objects.

Please keep this machine securely fastened in the truck during transportation to prevent it from collision or tumbling. Although the whole cabinet has an anti-shock design, we still recommend taking extra anti-shock care in the vehicles, especially on a bumpy road.

3.2 Inspection after unpacking

- Open the wooden cabinet, remove the packing material. Since the machine is pretty heavy, please pay special attention to prevent the machine from tumbling or falling down, while moving it to its final destination；
- Examine the machine after unpacking it. Check to see if there is any physical damage. If yes, do not install it and call Intepro Systems for help；
- Examine all the accessories, if anything is missing, please call Intepro Systems for help.

3.3 Requirements of the environment

Notes on the environment for operating the machine：

1) Ingress protection of the PEL-33060 is IP20, and for indoor use only. Location where the machine installed must have roomy space for air convection. Always keep the inlet and outlet (for air flow) clean and clear；

2) Make sure the location where the machine is installed has strong enough strength and is flat. No shaking or tipping is allowed once installed；

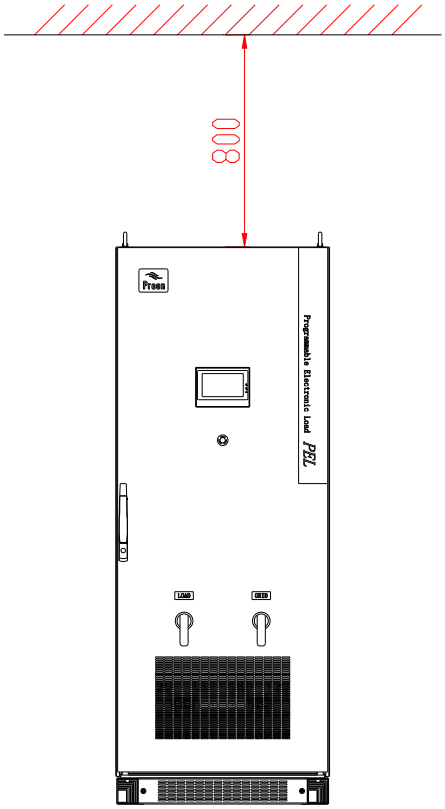
3) All the entrance and exit of the cable wires (for energy in and out) are in the bottom of this machine. It is recommended all cable wires be directed to the duct or gutter on the floor or ground, for easy layout and maintenance；

4) Sufficient space must be kept in surrounding area of the machine to ensure good air convection for heat dissipation (please see Fig. 3-2)；

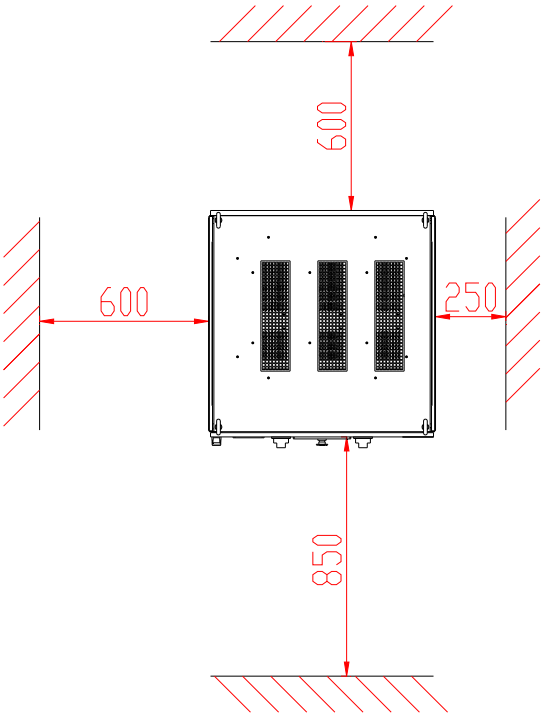
5) Try to avoid any of the following substances in the place where the machine is installed: heavy dust, heavy salt, corrosive chemicals or flammable chemicals. The life and reliability of the machine may be significantly affected;

6) Do not install the machine in a place where temperature or humidity may exceed the allowed limit (see table in Section 2.1). Keep the machine away from a heat source, direct sunlight or flammable vapors；

7) Follow strictly the instructions on wiring and adopt the proper gauge of cable wires, which can ensure both the safety of users and the integrity of the machine.



(a) Required space on the top



(b) Required space in surrounding area

Figure 3-2 Required space surrounding the machine

3.4 Instructions and illustrations on wiring

All the electrical cable wires connected to this machine are recommended to go through the reserved ducts or gutters on the floor ground. If not, the space between the feet of this machine and floor ground can be used for laying out those cable wires.

Main electricity cable wire connectors ：

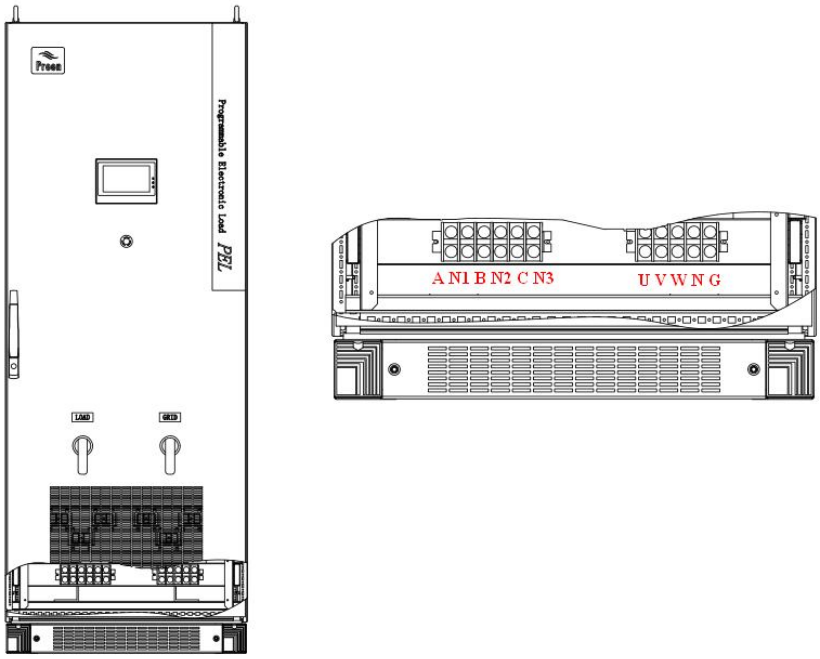


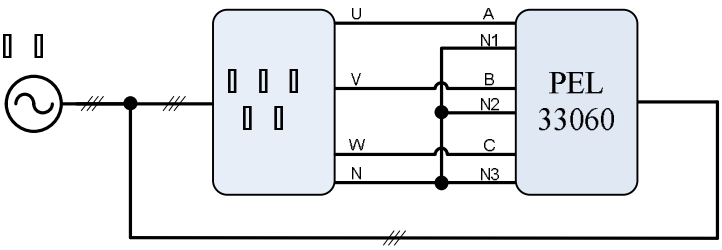
Fig 3-3 Illustration of busbar connectors

For the wiring between PEL, Unit Under Test (UUT) and utility grid pls. refer to Fig 3-4.

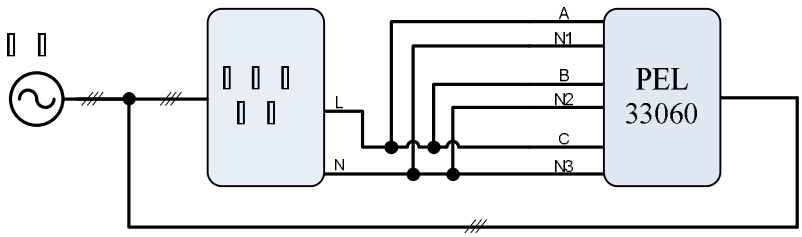
When three-phase UUT shall be tested under load or burn-in test, pls. refer to Fig3-4(a); namely connect U/V/W phase on UUT output side to A/B/C phase on PEL's load side respectively and then connect three-phase line N on PEL's load side to line N of UUT after being paralleled. PEL can run on the base of application/assignment application (three-phase balance load) or three-phase independent application (three-phase/unbalance load or single-phase load) through the operation on touch panel.

When UUT is single-phase with large capacity (larger than PEL's single phase capacity 20kVA, but no larger than PEL's overall capacity); pls. refer to Fig 3-4(b), parallel the power lines A/B/C on PEL's load side and neutral lines N1/N2/N3 on its load side and then connect them to power line L and neutral line N of UUT respectively.

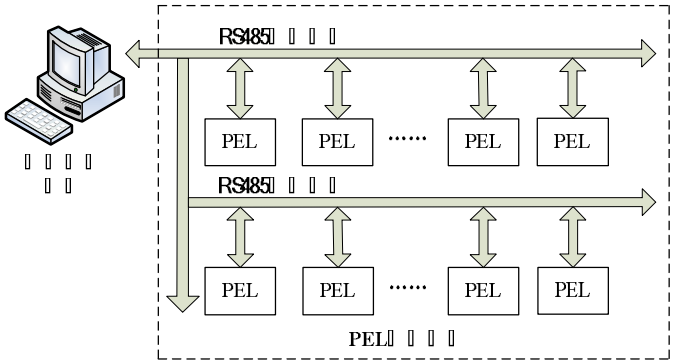
PEL can be connected in parallel for parallel operation, which is shown in Fig 3-4(c).



(a) Illustration of three phase UUT wiring



(b) Illustration of single phase UUT being parallel connected



(c) Illustration of PEL parallel connected

Fig 3-4 Illustration the wiring between UUT and PEL

3.5 Notes on wiring

1) Before connecting the cable wires, make sure all of the wires are not live (zero voltage). Use a voltmeter to check the voltage on all wires；

2) Make sure all the switches on the machine are in the OFF position；

3) Adopt proper gauges for all of the cable wires. Recommendations for those gauges are listed in the following table (Table 3-1):

Table 3-1 Gauges recommended

Model no.	Load side				
	A(phase B and C are the same to Phase A)		N1、N2、N3		G
PEL-33060	Current value	Cable wiring	Current value	Cable wiring	Cable wiring
	90A	$25mm^2$*1	90A	$25mm^2$*1	$10mm^2$*1
	Grid connected side				
	U(Phase V and W is the same to phase U)		N		G
	Current value	Cable wiring	Current value	Cable wiring	Cable wiring
	90A	$25mm^2$*1	90A	$25mm^2$*1	$10mm^2$*1

The above - referenced table recommends to use multi-core soft copper cable. The user may select for other cables after referring to the input/output current condition; it is advisable to double cable diameter if the length is over 20 meters long for the input or output cable.

4) Connect distribution lines on load side to their corresponding wiring terminals by sequence correctly, while the distribution line on grid connected shall be connected to the connection terminals of electric supply.

Note: the relation for wiring (A, B, C and U, V, W generally corresponds to yellow, green and red; N lead generally corresponds to blue, G lead generally corresponds to yellow-green); must not make live operation; must consider remained lead line voltage drop at time of relatively longer input/output lead.

4 Operation

4.1 First time start up

After finishing making all connections of the load side and grid connected side cable wires, please double check the voltages on all the load terminals and grid connected terminals; the voltages must be within the limits specified in Table 2.1. If not, do not turn on the machine.

Recheck everything, fix the problem(s), and redo the procedures. Now users can turn on the input switch (NFB), and the system will start running immediately. The fans inside the machine should be running as well. The touch panel should have the display on. If no abnormal phenomenon is observed, then the machine is now ready for setup and programming.

Notes: The sequence of turning on the circuit breakers of the load side and grid-connected side is not strictly required, but the power for PCBA for the internal controller is supplied from the power of grid-connected side. Therefore, the touch panel will be active only when the circuit break on the grid-connected side is turned on. (The voltage on each terminal board shall be confirmed before the circuit breaker on the load side and grid- connected side are turned on).

4.2 Instructions on UI (user interface) software

It is the premise for the UI's giving its best performance to set correct parameters for PEL; as such, a detailed introduction about the starting interface and user mode follows.

4.2.1 Initializing

After the PEL is electrified: starting the UI, the first screen displays as in Fig. 4-1:

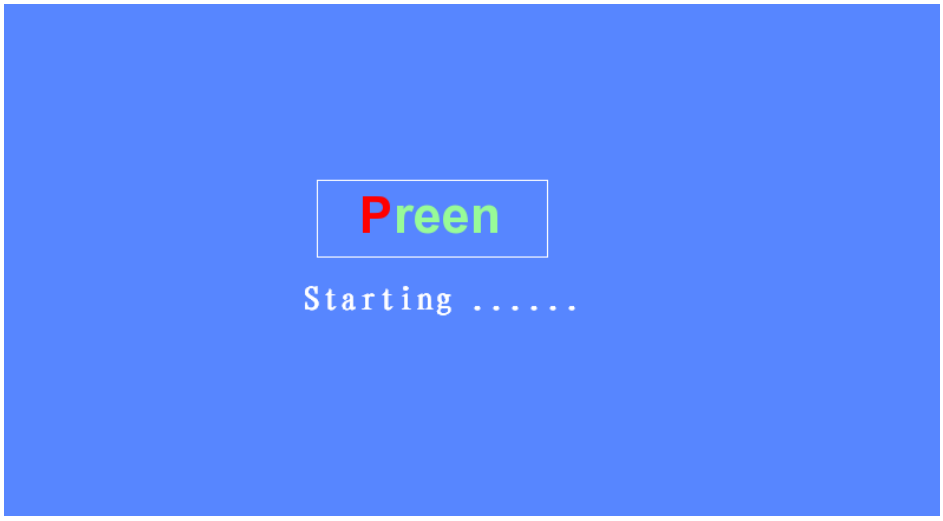


Figure 4-1 UI startup interface

The initialization continues as in Fig 4-2:

Fig 4-2 Initialization screen

4.2.2 User mode

Entering the starting menu in the user mode, the screen displays as in Fig. 4-3:

Fig 4-3 Starting menu in the user mode

- 【APP】Enter the menu of setup/programming of the operations;
- 【SYSTEM】Enter the system setup menu；
- 【EVENT】Enter the menu of events log.

4.3 Application interface

There are four tabs in the “Applications” menu. They are “GENERAL”, “PROGAM”, “SINGLE” , and “MEASURE”.

Note: The following figures are for illustration of the UI and are general figures only. Actual information in the figures should be obtained from the real display on the touch panel for the specific model of machine.

4.3.1 General operation

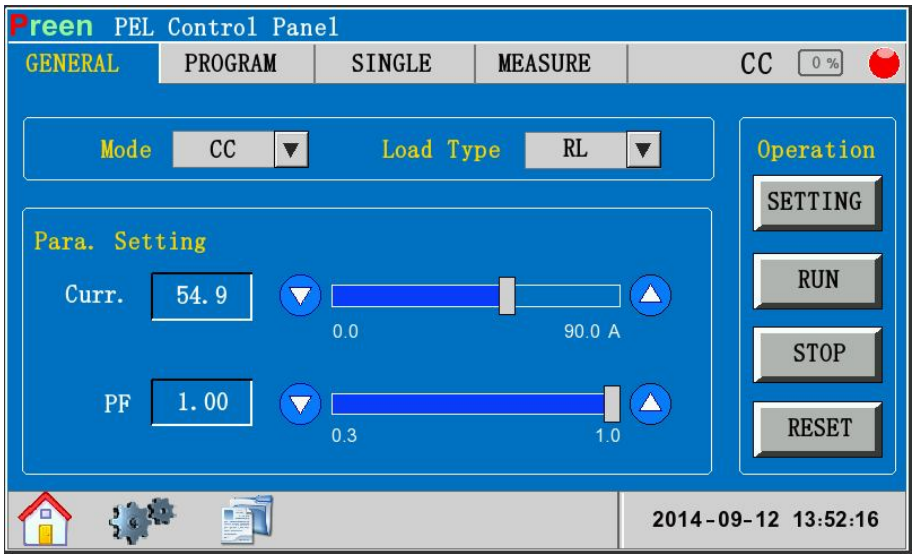


Fig 4-4 Basic application settings interface

- 【Mode】 There are three specific working modes: constant current mode, constant resistance mode and constant power mode;
- 【Load Type】 RL means the PEL can simulate the resistance and inductive load that you can setup the power factor in below from 0.3 to 1.0;
- 【Para. Setting】Take *constant current mode* as example, the effective value and PF of current can be set, there are three setting modes for selection:

  a) Type in the voltage value 10.0 in this box; the keyboard will pop up for typing when you click in the field;

  b) Make adjustment through moving it from left or right in the bar 0.0 90.0 A ;

  c) Click ▼ & ▲ for setting, which is changed by 0.1.

- 【SETTING】After finishing the typing-in of current and PF, click *SETTING* Button for sending current and PF value to each module as final target value;
- 【RUN】After clicking, the device is starting to simulate the load characteristics in accordance with set value;
- 【STOP】 The device will come into stop after your clicking;
- 【RESET】Alarm will be cleared after your clicking (***Notes: the button will be effective only under fault state.***);

- 【 】Indicating light can show the running state of the device: Red: device in halt, Green, device in running.
- 【CC】Showing the current working mode, among which CC, CZ and CP means constant current, constant resistance and constant power respectively;
- 【 】Showing the load capacity, namely actual value/ maximum simulation value.

4.3.2 Program operation

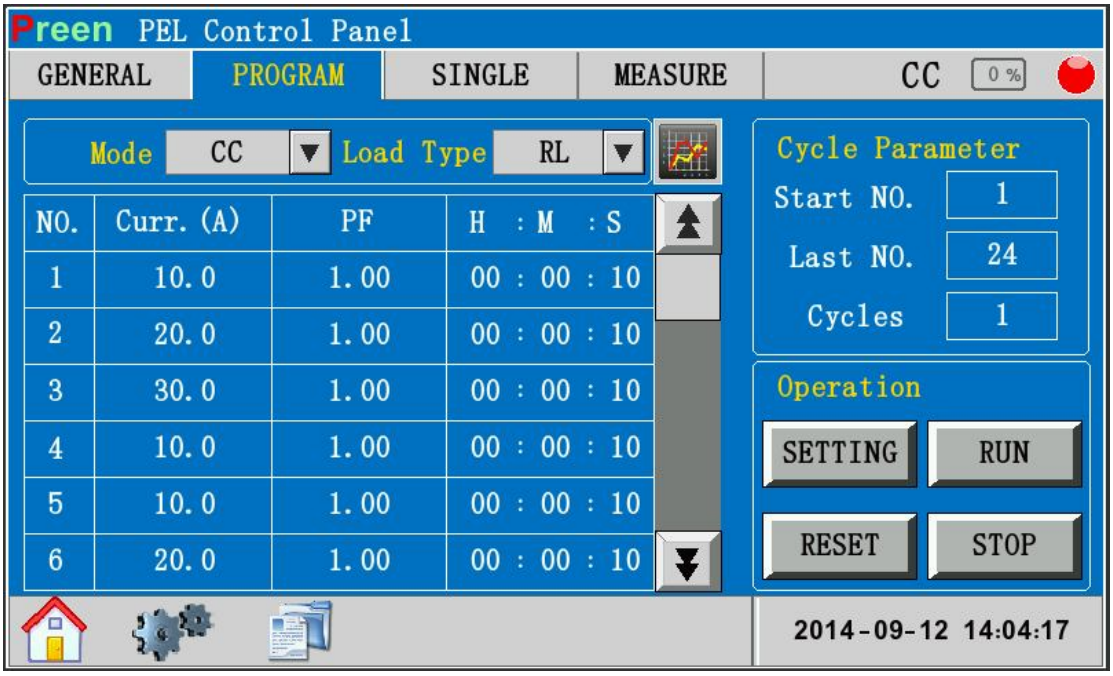


Fig 4-5 Program operation interface

- 【SETTING】 Sending actual running parameters to PEL through touch panel (The current, PF and running interval);
- 【RUN】After clicking, the device is starting to run in accordance with set value;
- 【STOP】 The device will come into stop after your clicking;
- 【RESET】Alarm will be cleared after your clicking (***Notes: the button will be active only under fault state.***);
- Switching the setting interface and preview interface of PROGRAM.

4.3.3 Single operation (Three-Phase independent settings)

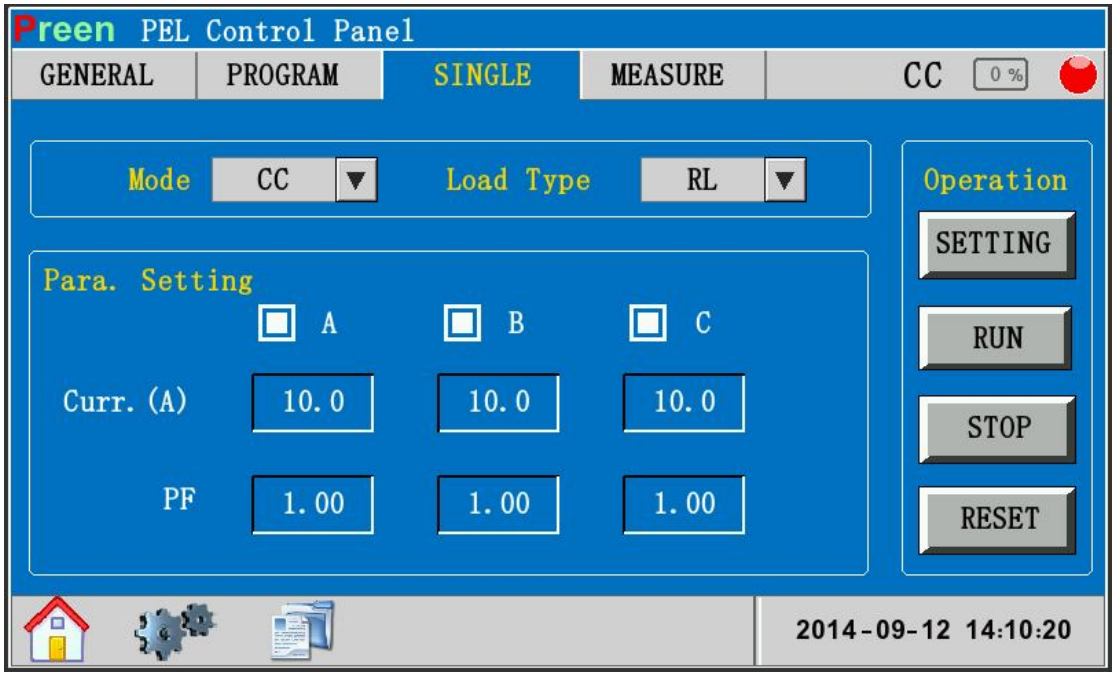


Fig 4-6 Three-phase independent settings interface

- 【SETTING】 Sends actual running parameters to the power module through the touch panel and sets value of current and PF;
- 【RUN】After clicking, the device is starting to run in accordance with set value;
- 【STOP】 The device will come to a stop when selected;
- 【RESET】Alarm will be cleared after clicking (***Notes: the button will be active only under fault state.***);
- 【☐】Check box, used to enable or disable corresponding phase; enabled state is white;

4.3.4 Measure operation

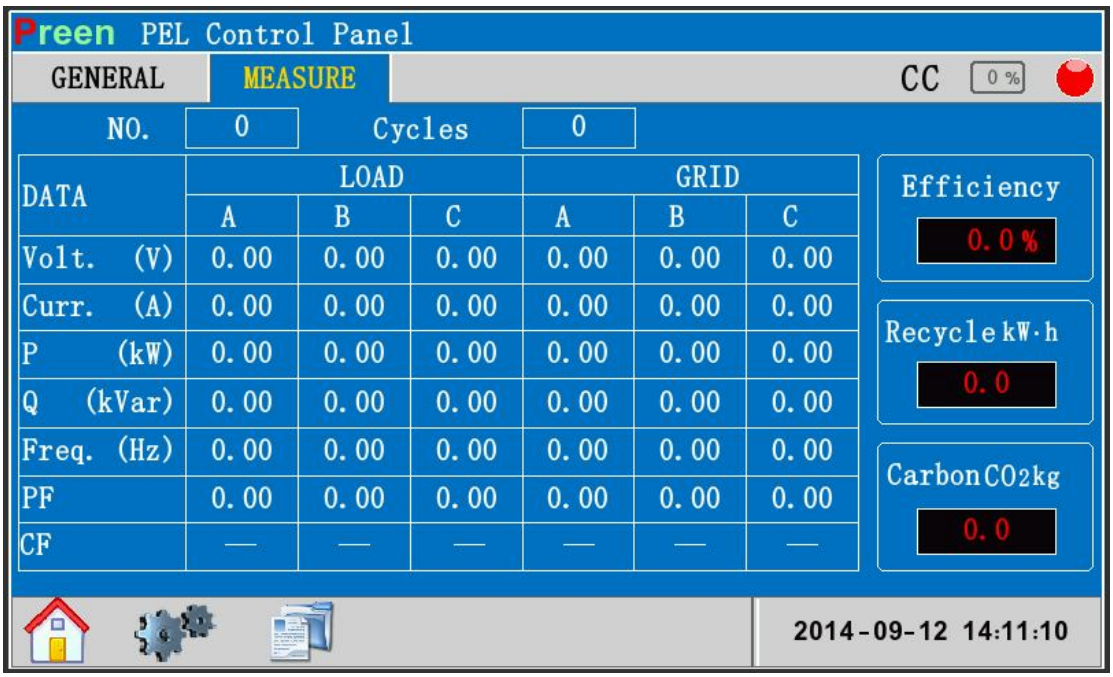


Fig 4-7 Real-time acquisition interface

- 【Efficiency】Showing the efficiency of the feeding power to grid;
- 【Recycle kW.h】Showing the total saving energy in kWh
- 【Carbon CO2 kg】Showing the Carbon CO2 reduction value from converting the kWh of energy saving.

4.3.5 System settings interface

The menu for system settings is as in the below picture：

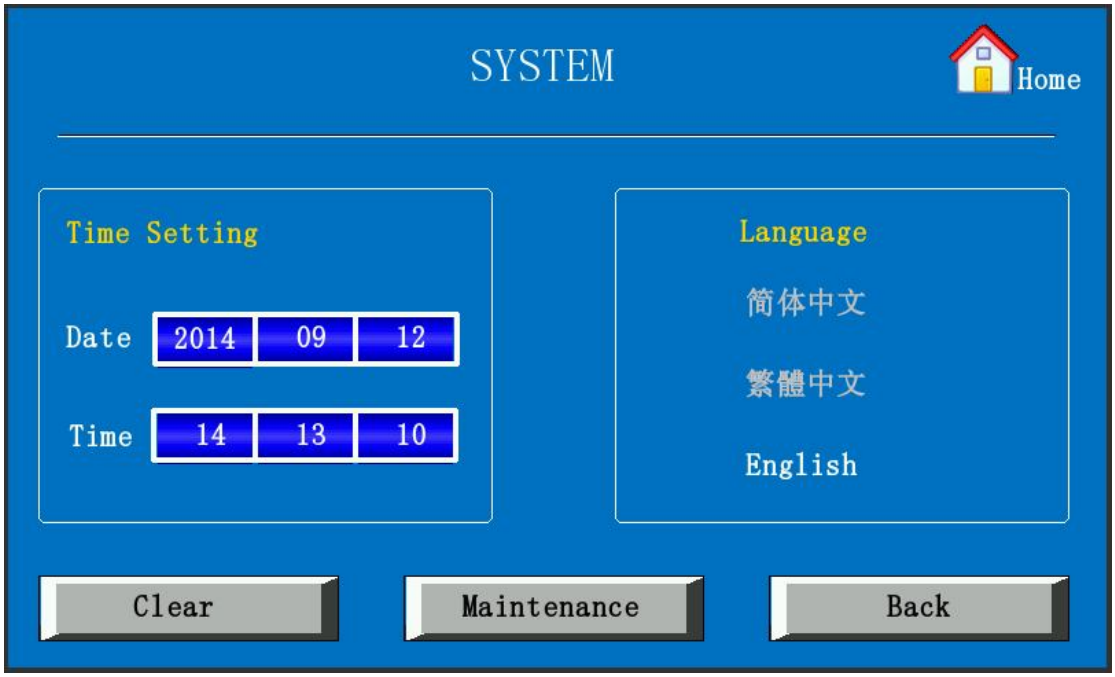


Fig 4-8 Menu for system settings

- 【Time setting】 Current date and time (Date, Hour, minute and second) can be set here;
- 【Language】Only simplified Chinese, traditional Chinese and English are available now;
- 【Clear】 The values in box 【Energy-saving】 and【Carbon emission reduction】will be cleared to zero and re-accumulated；
- 【Maintenance】 Under normal condition, user can not enter this interface for amending system parameters. If it is still needed, pls. contact manufacturer or customer service;
- 【Back】 Returning to main menu.

4.3.6 Events log

The events log displays as below:

Fig 4-9 Events log display

- 【Previous】/【Next】： Review all the events on every page;
- 【Clear】： Clear all the events in this log；
- 【Back】： Return to the main menu.

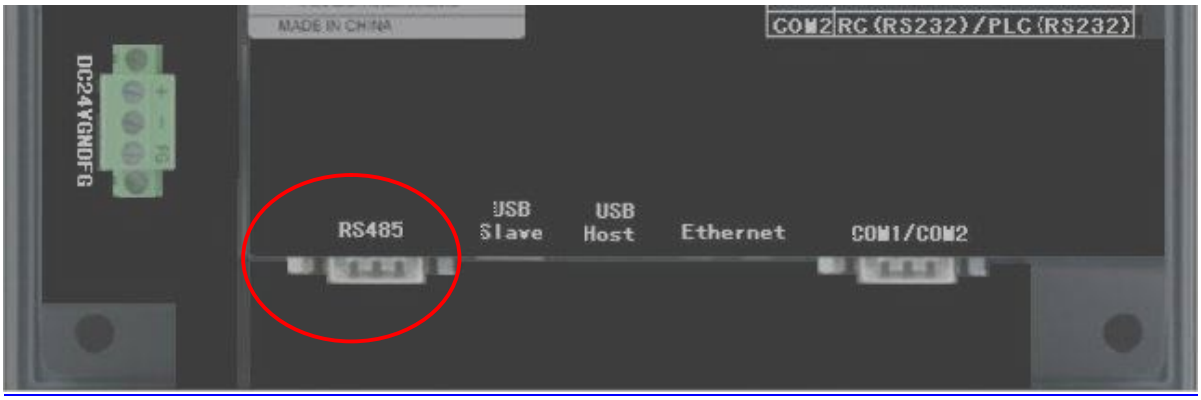
5 Remote Control

5.1 Communication interface

RS485 is a standard communication connector for this series of machines.

5.1.1 Connector of RS485

Open the front cover, the RS485 connector is located in the back of the touch panel computer, shown in the figure below:



a) Touch panel backware interface diagram

RS485 D-Sub 9 Connector Pin Definition		
Pin Number	Signal	PC
1	Rx- (B)	RS485B
5	GND	Ground
6	Rx- (A)	RS485A

b) RS485 interface descriptions

Fig. 5-1 RS485 interface schematic diagram

5.1.2 Indication of remote control on touch panel

While the communication channel of this machine is successfully linked with other computing equipment, there will be an indication text “Remoting …” shown on the screen, as in the below Figure 5.2:

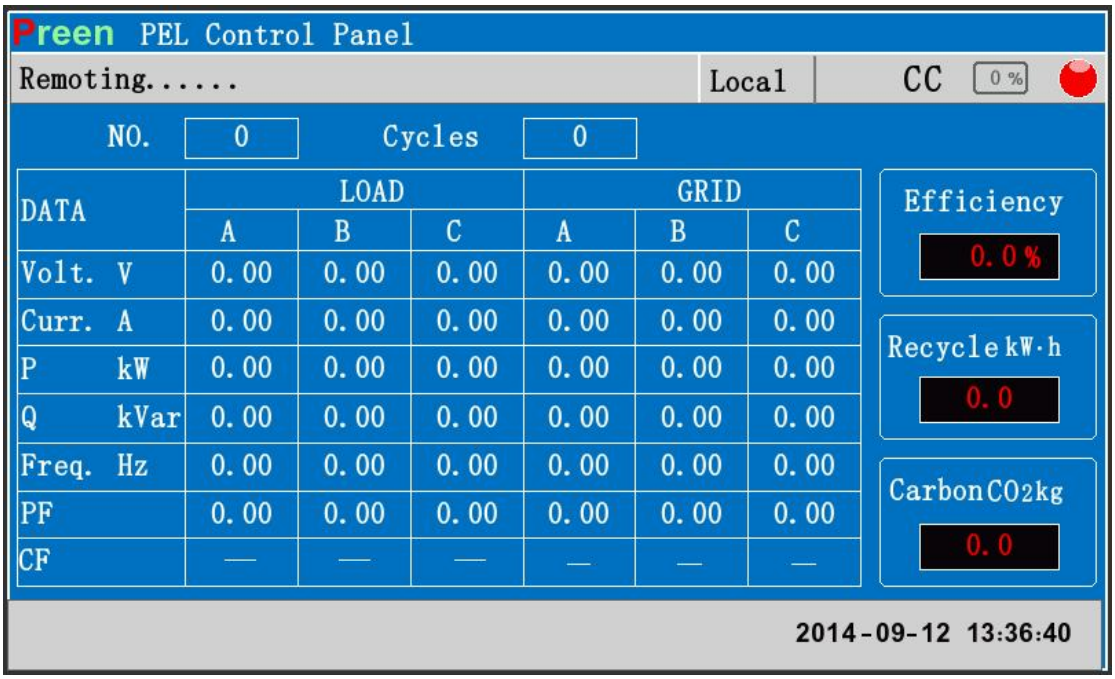


Fig 5-2 “Remoting…” shown on screen

5.2 Operations of remote control on PC

5.2.1 Software installation

Open the software CD package, install the software by executing the setup.exe on the CD, as shown in the below picture.

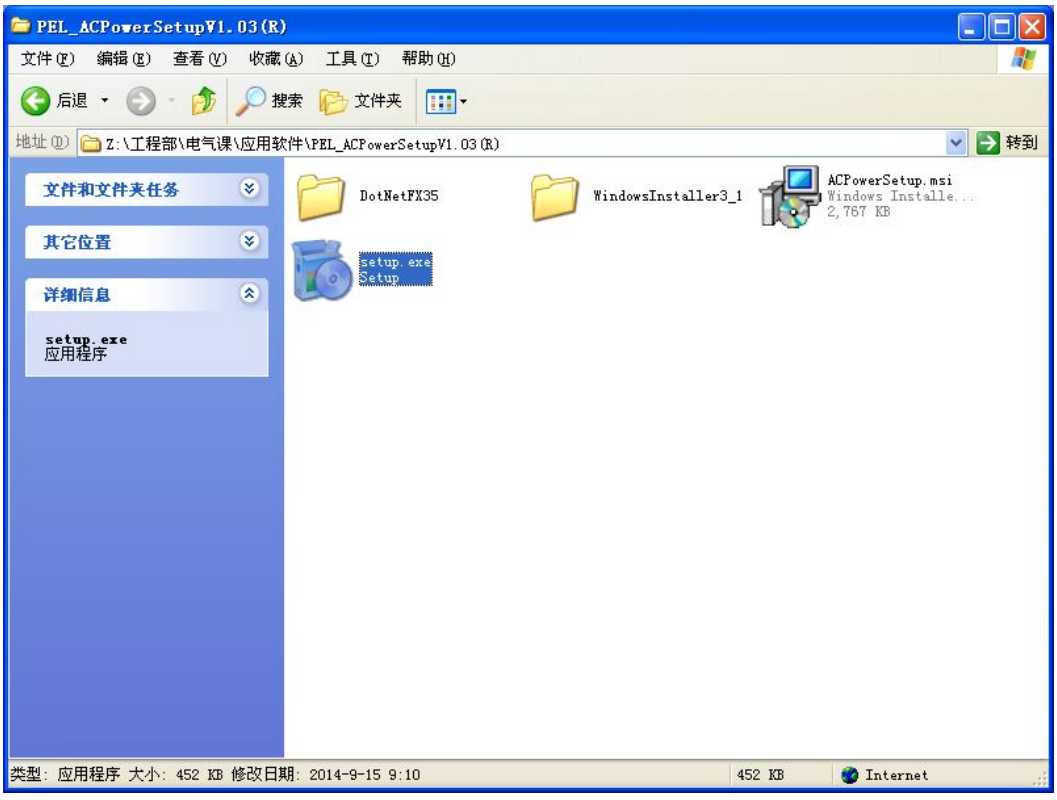


Fig 5-3 Software installation kit on the CD

Operating systems supported: Windows XP、WIN7、WIN8.

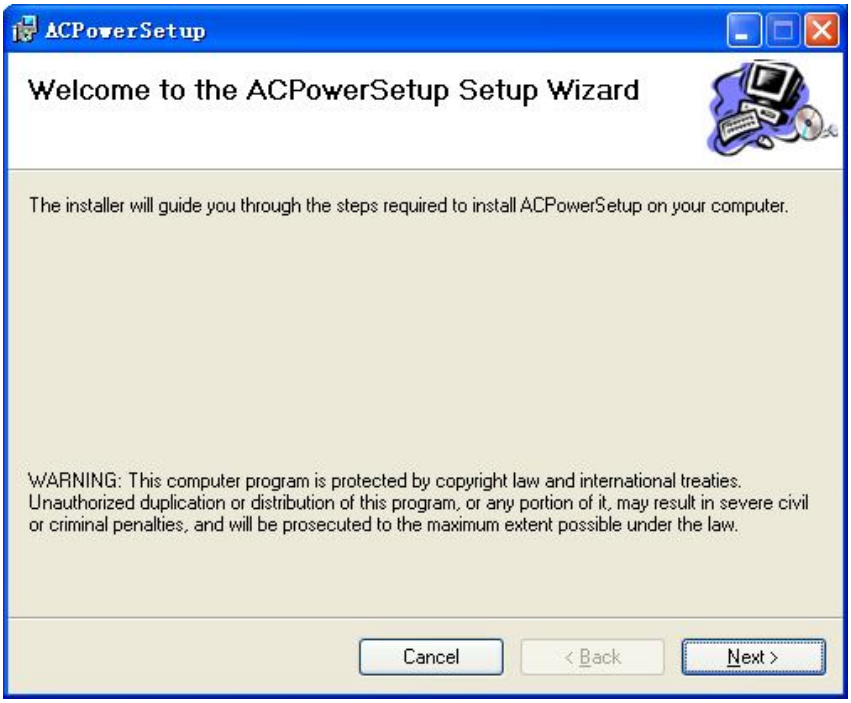

ACPowerSetup
Welcome to the ACPowerSetup Setup Wizard
The installer will guide you through the steps required to install ACPowerSetup on your computer.
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.
Cancel
< Back
Next >

Fig 5-4 First step of the installation

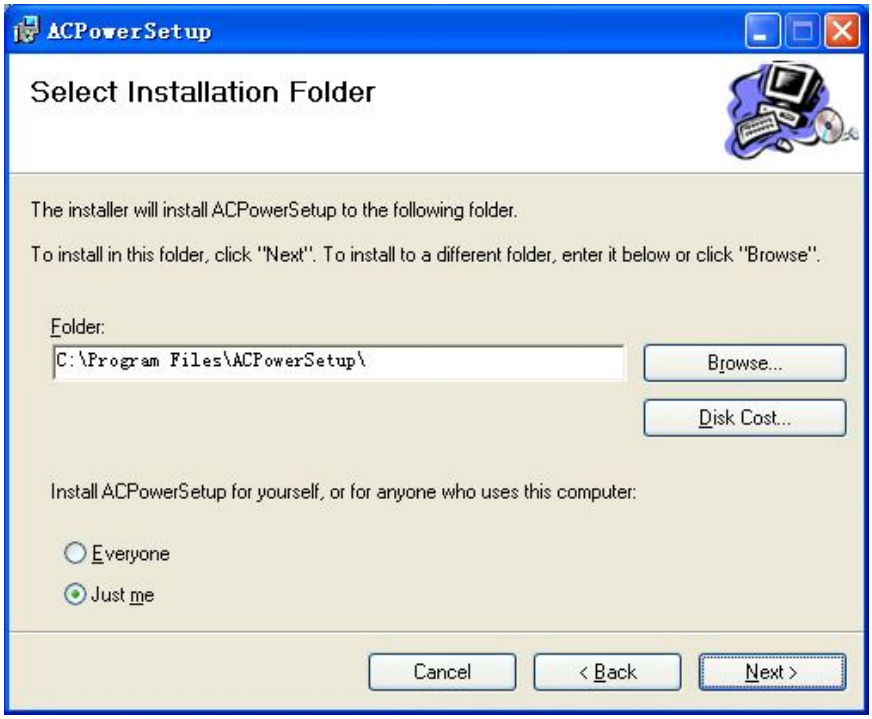

ACPowerSetup
Select Installation Folder
The installer will install ACPowerSetup to the following folder.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:\Program Files\ACPowerSetup\
Browse...
Disk Cost...
Install ACPowerSetup for yourself, or for anyone who uses this computer:
Everyone
Just me
Cancel
< Back
Next >

Fig 5-5 Second step of the installation

Choose the language for use in the software. It is recommended to install on a non-system disk drive (e.g. D:\ disk).

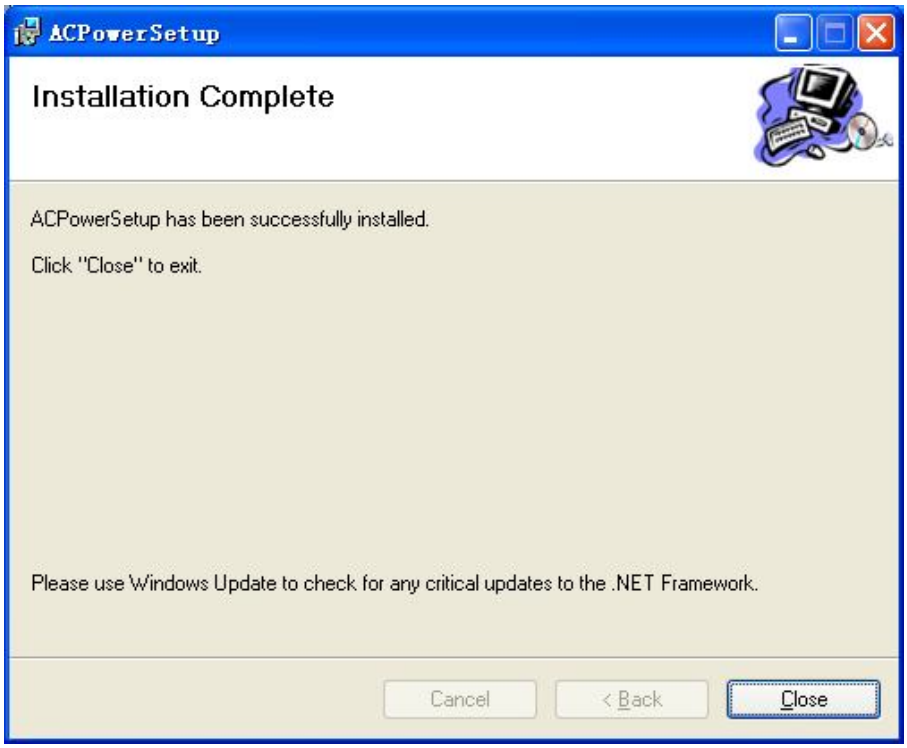


Fig 5-6 Third step of the installation

Fig 5-7 Shortcut on the PC desktop after successful installation

5.2.2 Operations on PC

5.2.2.1 Main remote interface (not connected)

Double click the shortcut (as shown in Fig. 5-7) on the desktop, then enter the system main menu (as shown in Fig. 5-8). Before communication channels are successfully linked, all the major action buttons such as【Run】、【Stop】、【Reset】and all the drop down menus such as “General operations”, “Output monitoring”, “Specific applications” are all grayed out (and cannot function).

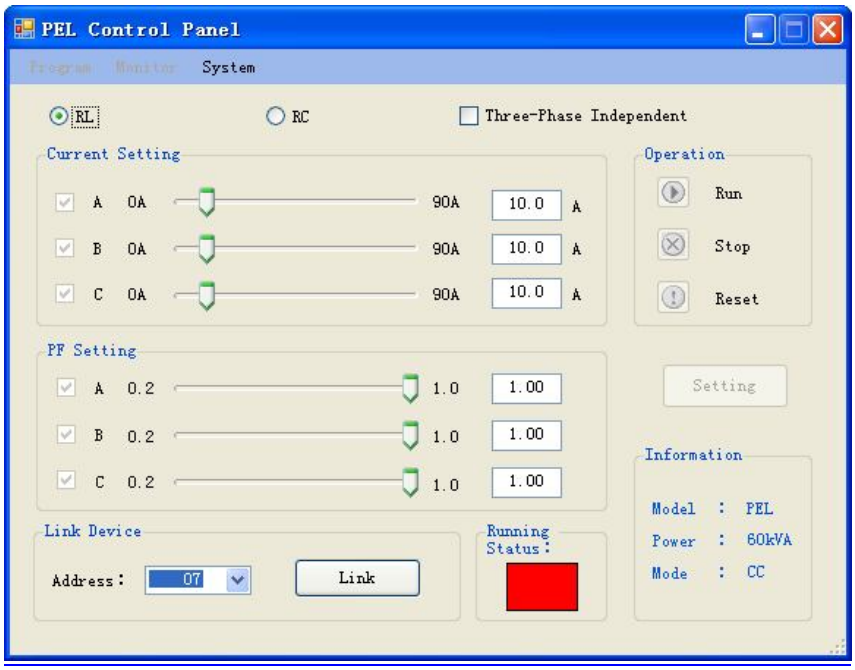


Fig 5-8 Remote-control interface - not connected

5.2.2.2 Communication setting interface

Click【System】in the menu then click COMM Setting, *communication settings* interface will appear as shown in Fig 5-9. Communication parameter shall be set as follows:

The address of the device: 7(default value)

Communication mode: RS485 (default value)

Serial port no.: Choose in accordance with the serial port of actually-adopted PC.

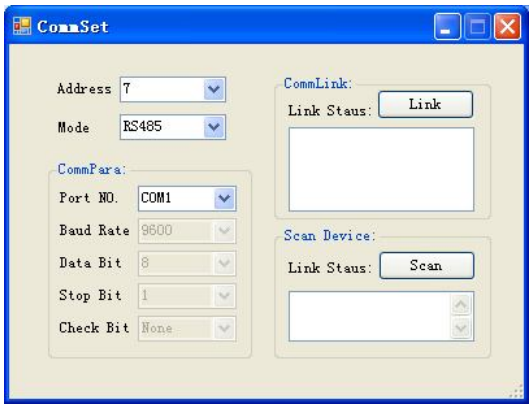


Fig 5-9 Communication settings interface

Click the 【Link】button after set-up completes, and if the configuration is correct. *Serial port is open and device is connected* will be shown in the Link Status.

5.2.2.3 Main remote interface (Connected)

After successful connection to PEL, the main interface will be unlocked as shown in Fig 5-10:

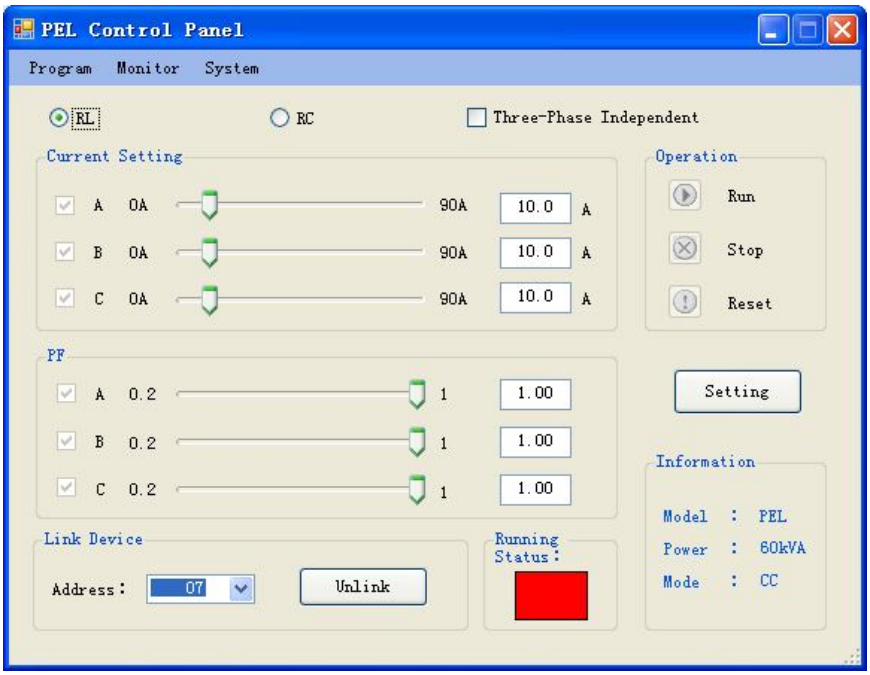


Fig 5-10 Remote-control main interface (already connected)

Fig 5-10 is the default interface of *general application* and *three-phase independent*, among which there is a check box before *three-phase independent setting.* If it is selected, *general application interface* will be switched to *three-phase interface*; if not, it will be *general application interface*.

5.2.2.4 General application (Three-phase) interface (working mode settings)

Click【System】 in the menu as shown in Fig 5-11, choose 【Work Mode】in pull-down menu, the working mode of PEL can be selected here. After choosing the working mode successfully such as constant current mode, the effective value and PF value of the current you would like to simulate can be chosen.

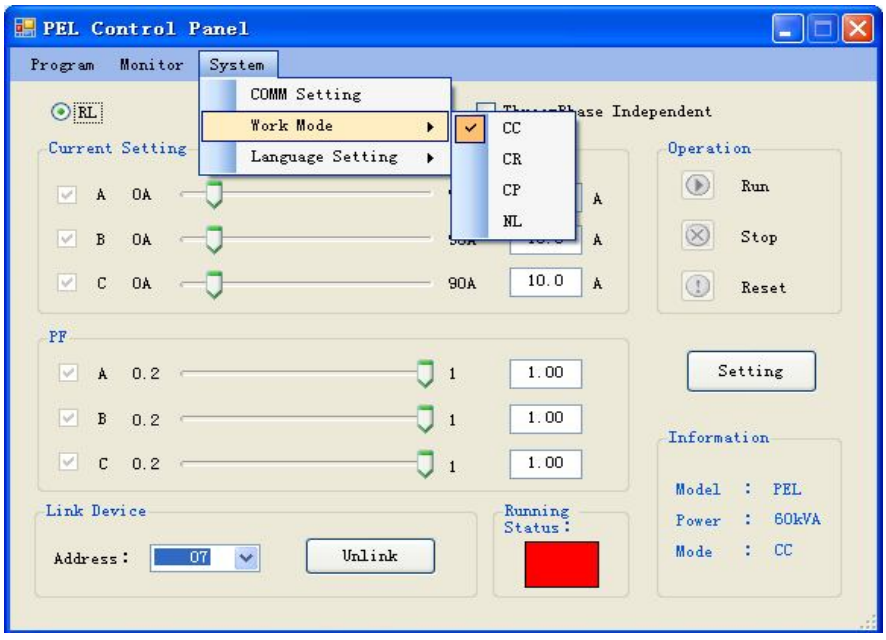
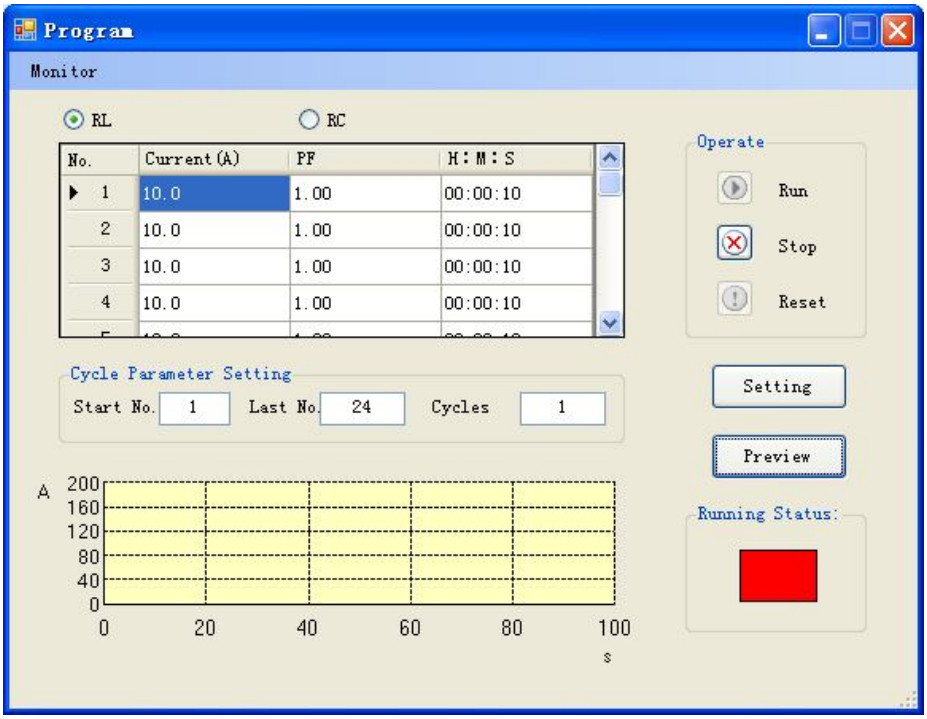


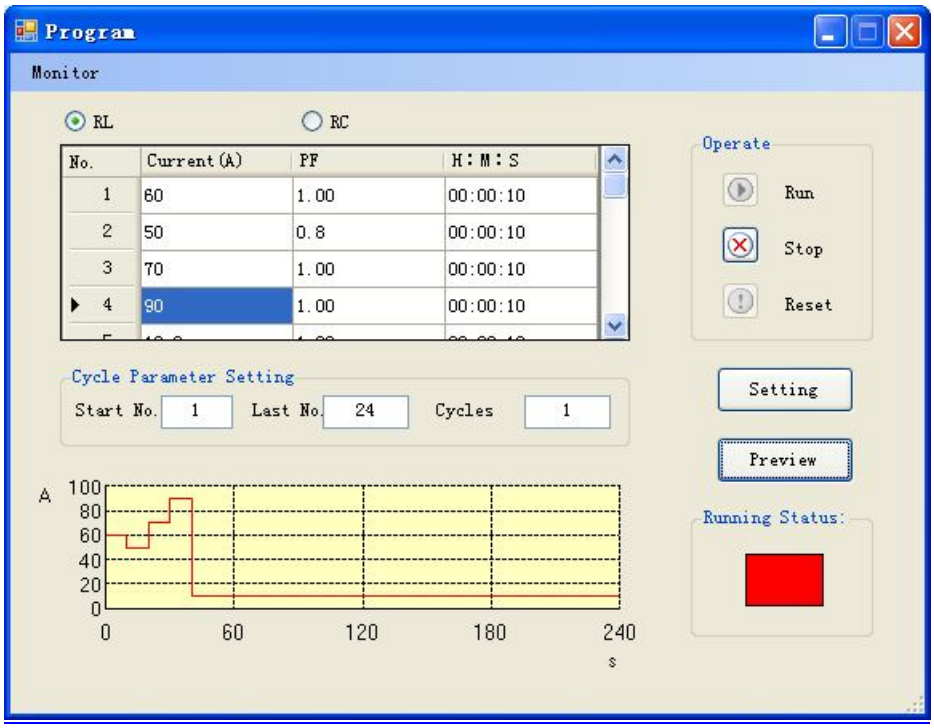
Fig 5-11 Basic application (three-phase independent) interface

5.2.2.5 Program application interface

In general application interface click【Program】 in the menu and enter program application interface as shown in Fig 5-12.



(a) Task application settings interface



(b) Preview Fig of task application settings interface

Fig 5-12 Task application interface

- Set up Start No., Last No. and cycles times. A maximum of 24 groups and 255 cycle times can be set up;
- After the user sets data successfully, you can click【Settings】for downloading data;

- Click 【Preview】to review operation schematic diagram about set data;
- 【 】State indicating light: Red means the device is in stop status, while green means the device is in operation state;
- 【Running】After clicking, the device is starting to run in accordance with set values;
- 【Stop】 The device will come into stop after your clicking;
- 【Reset】Alarm will be cleared after your clicking.

5.2.2.6 Real-time Monitoring interface

In the general application interface and program application interface, click【Monitor】menu and enter real-time monitoring interface as shown in Fig 5-1:

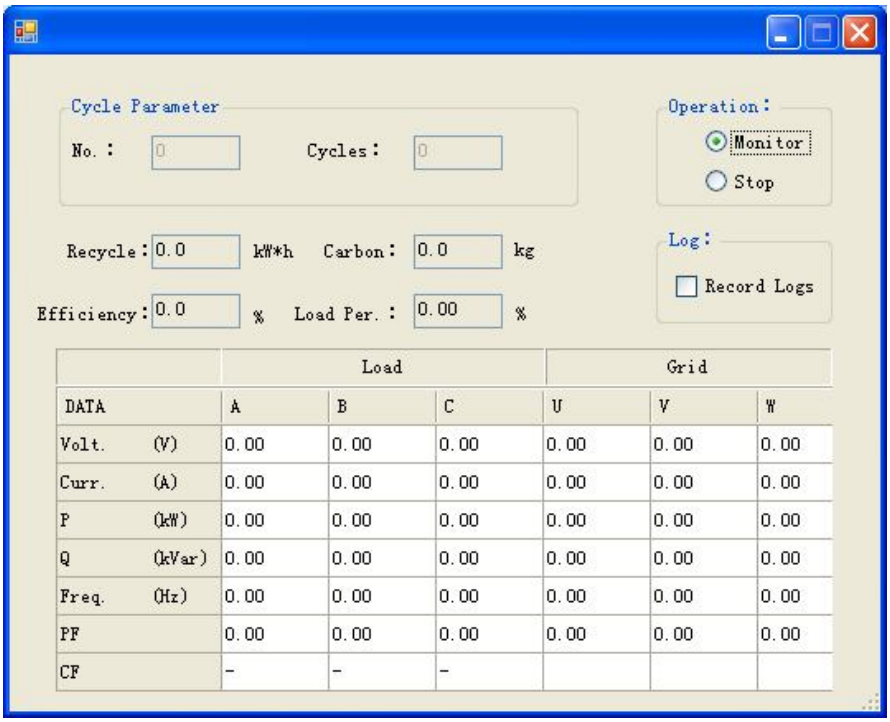


Fig 5-13 Real-time remote acquisition interface

- Whether to load data or save the log is available for selection;
- Acquisition can be controlled or halted.

Notes 1: Real-time acquisition can be entered only under running state.

Notes 2: After user connects remote control successfully, it can be unlocked through pressing 【Local】.

6 Theory of the functions of machine

6.1 Block diagram

Functional blocks (from input to output) of the PEL series regenerative AC load bank are shown in Figure 6-1:

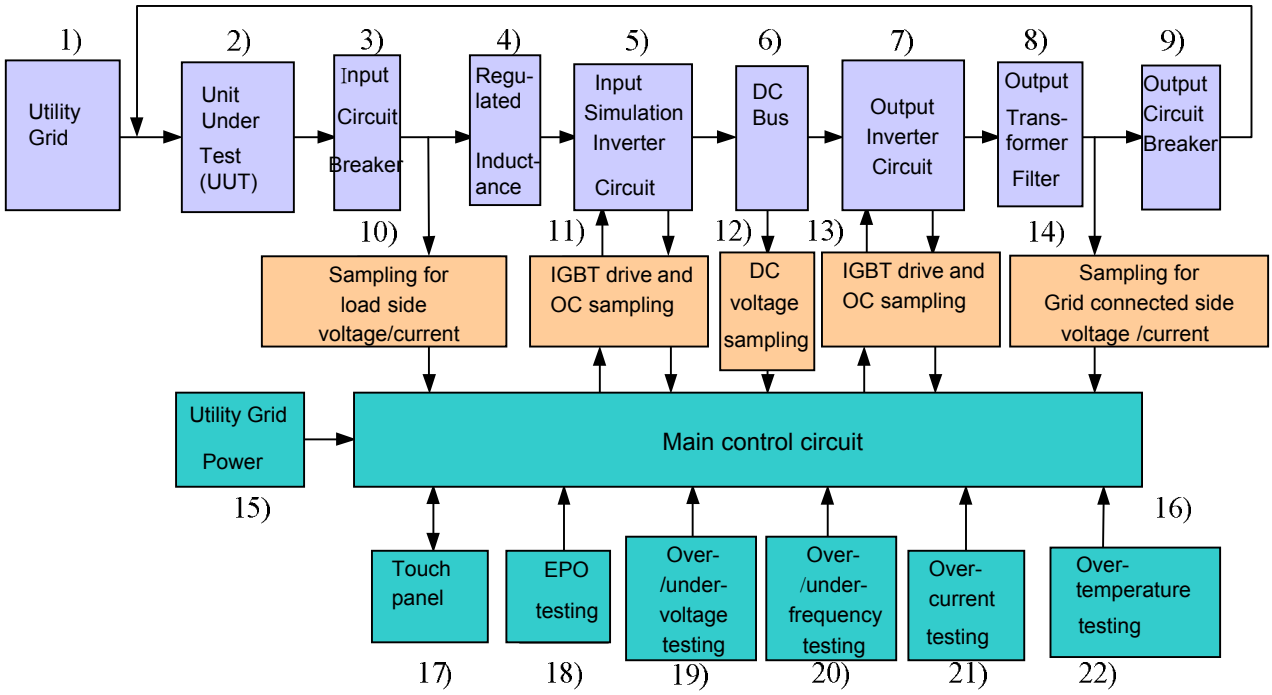


Fig 6-1 Functional block diagram

6.2 Illustration of the block diagram

1) Utility Grid: Utility grid shall be connected to input side of unit under test (UUT)
2) Unit Under Test (UUT): UUT shall be connected to the load terminal of PEL device
3) Input circuit breaker: Turn on/off between the output side of UUT and the input side of PEL.
4) Regulated Inductance: Energy buffering for the input side of PEL and output side of UUT
5) Input Simulation Inverter Circuit: Simulating load characteristic in each phase
6) DC Bus: DC Bus
7) Output Inverter Circuit: Inverting energy from DC to AC and synchronizing with grid.
8) Output Transformer Filter: Energy buffering for the output converter and utility grid
9) Output circuit breaker: Turn on/off between the output side of PEL and the utility grid.
10) Sampling for load side voltage/frequency: Measuring input voltage and current for control board calculation on PEL.

11) IGBT drive and OC sampling: Drive signal to IGBT and sensing for over current.
12) DC voltage sampling: Measuring the voltage of DC bus for control PCB.
13) IGBT drive and OC sampling: Drive signal to IGBT and sensing for over current on grid connected side.
14) Sampling for Grid Connected Voltage and Current: Measuring the voltage and current on grid connected side for control calculation.
15) Utility Grid power: All supply powers on PCB from utility grid
16) Main control circuit: Control algorithm, main digital signal processor in PEL
17) Touch panel: Operation and control on human machine interface.
18) EPO: Emergency Power Off.
19) Over/Under-voltage test: Conducting over/under-voltage test on load and grid connected side.
20) Over/Under-frequency test: Conducting over/under-frequency test on load and grid connected side.
21) Over-current test: Conducting over-current test on load and grid connected side.
22) Over-temperature test: Testing the internal temperature of IGBT.

6.3 Construction of main control circuit

The main control circuit is mainly divided into the three parts, namely protection sampling module, main control module and display control module. The relationships between these three parts are shown in Fig. 6-2.

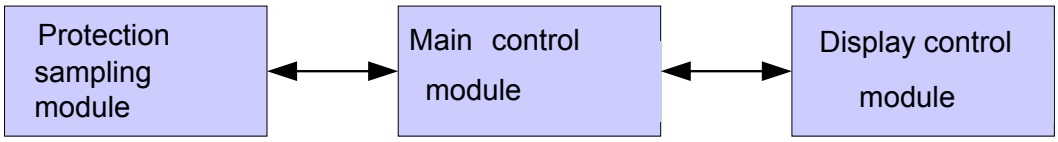


Fig 6-2 Block diagram of control parts

6.4 Characteristics curve of working mode

The application types of the PEL-series Regenerative AC Load Bank can be classified into general application, program application and three-phase independent (single) application. Under the general application, three-phase balance load can be simulated and can be programmed for 24 groups with 255 cycle times

Under a three-phase independent (single) application, one, two or three of the three phases can be run at the same time. All three types include the three working modes: constant current mode (CC), constant resistant mode (CZ) and constant power mode (CP).

Their respective working power characteristics curves are shown as Figure 6-3, Figure 6-4 and Figure 6-5.

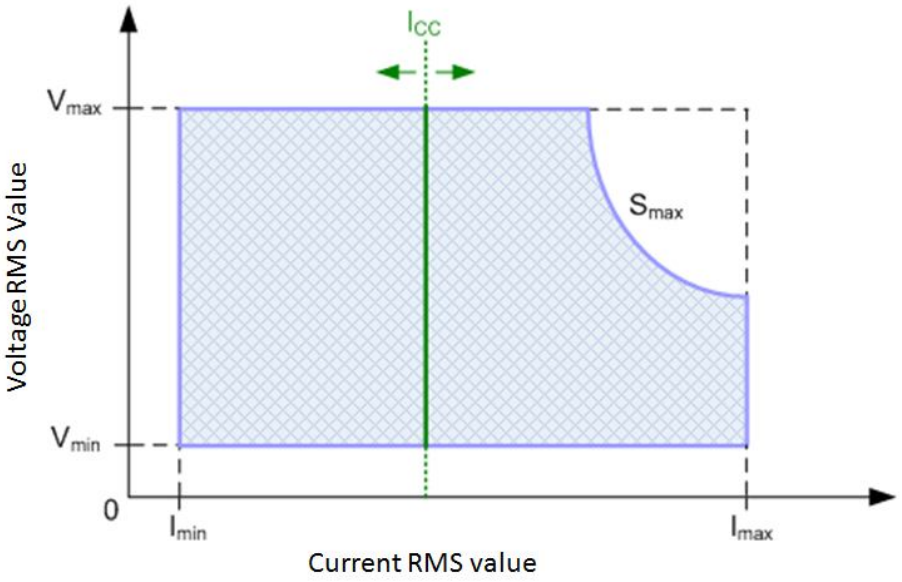


Fig 6-3 Constant current (CC) mode

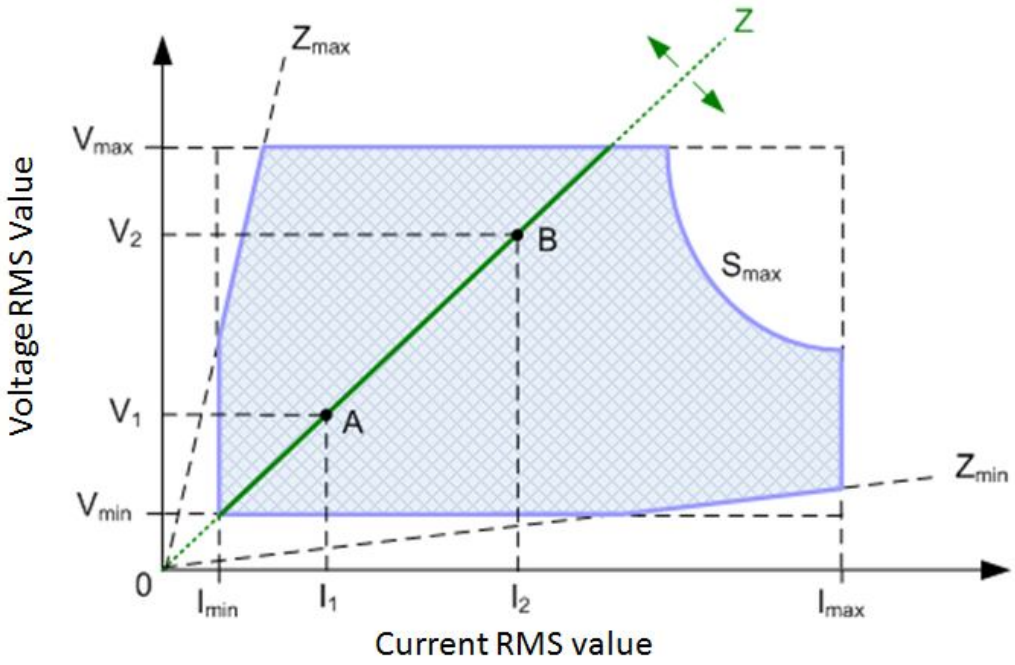


Fig 6-4 Constant resistance (CZ) mode

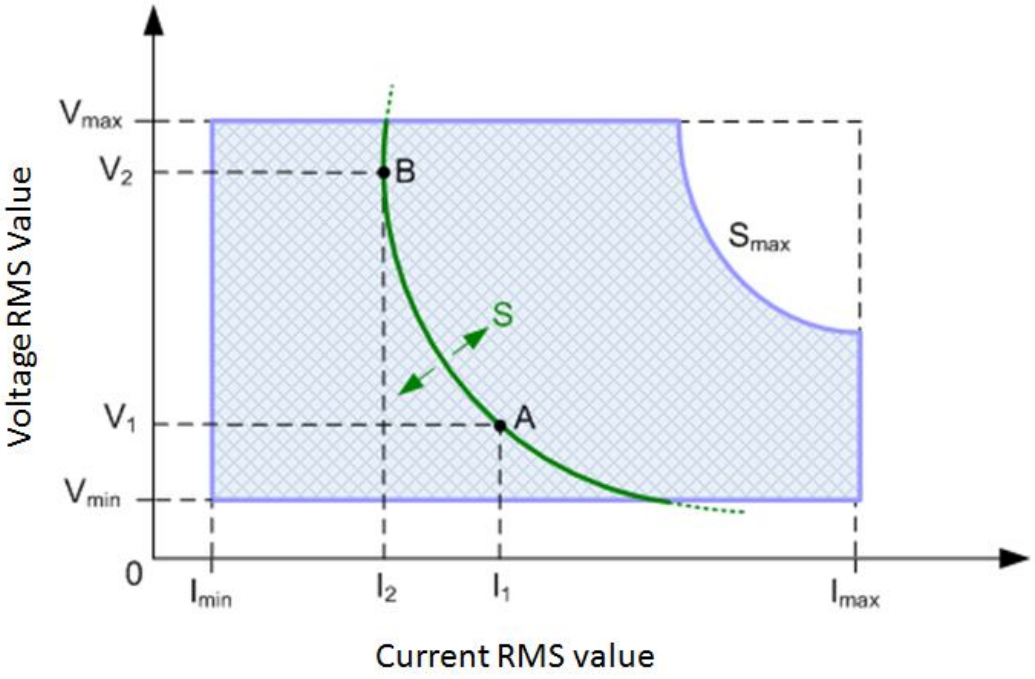


Fig 6-5 Constant power (CP) mode

7 Maintenance

Extreme temperature, high humidity, heavy dust, chemical pollution and physical vibration all could impose negative impacts on the life and reliability of this machine. The natural aging of all of the electrical and mechanical components would also cause the machine to be susceptable to all kinds of faults. Therefore, routine and periodic maintenance are necessary and key to the reliability of this machine over time.

Only authorized and trained technical professionals are allowed to carry out the maintenance on this machine.

7.1 Routine maintenance

First, the daily operating environment must comply with the requirements stated in this user manual. Routine inspection of the environment and the machine should be done on a regular basis. All the environmental data, the operating status and the parameters set in the machine should be recorded as well. It is best to have a detailed and accurate “machine usage log file” for time reference and maintenance.

Abnormal issues on the machine can be detected by the routine inspection and maintenance. Once observed, the root cause should be identified and the problem resolved immediately. Call Intepro Systems if you are not able to identify the cause, or not able to resolve the problem. The earlier we can solve the problems, the longer the life of the machine. Items to be checked as part of routine maintenance are listed in Table 7-1.

Table 7-1 List of checking items on routine maintenance

Object to check	Inspection details			Criteria
	Checking items	When to check	Methods to check	
Environ-ment	(1). Temperature and humidity (2). Dust, moisture and water leakage (drop on the machine). (3).Abnormal Chemical vapor	Anytime	(1).Thermometer, Hygrometer (2). Visual inspection (3). Visual inspection and smell	(1). Ambient temperature must < 40°C, or maximum load need to be de-rated. Humidity should be comply with the spec requirements. (2). Little dust, no condensing, no water drop on the machine. (3). No abnormal smell, no abnormal color in the air.

This machine	(1) Shock, vibration (2) Heat dissipation (3) Acoustic noise	Anytime	(1) Visual inspection, sense of moving. (2) Thermometer (3) Sense of hearing	(1) No shock, no vibration (2) Fan operating: check to see if speed and air flow volume OK or not. Measure the temperature on the surface of the enclosure; they should not have more than 30°C temperature rise. (3) No abnormal acoustic noise.
Input / Output status	(1) Input voltage (2) Output voltage (3) Output current (4) Temperature inside the machine	Anytime	(1) Voltmeter (2) Voltmeter (3) Ammeter (4) Thermometer	(1) within the spec limit (2) within the spec limit (3) within the spec limit (4) Temperature rise < 40°C

7.2 Periodic maintenance

Depending on the usage of this machine and the environment where it works，a periodic maintenance can be carried out once every 3~6 months.

Maintenance task：

Screen filter for the air inlet should be detached and washed clean。

Note：Open the front door of the enclosure to detach and re-install the screen filter, there is a cover in front of the screen filter, it needs to be removed before the filter can be accessed.

7.3 Trouble Shooting and Solutions

Before seeking service, users can first do a self-inspection and record fault phenomena in details according to the tips in this section. When you need to seek service, please contact Intepro Systems.

Table 7-2 Alarm content & solutions

Fault Type	Possible Causes of Faults	Solutions
Grid frequency over limit	Grid frequency over the range of device supported	Check frequency of grid voltage
Inverter NPLL	The phase loop of Inverter not locked	Check grid voltage
Grid voltage too low	Grid voltage lower than lower limit value	Check grid voltage
Input frequency over limit	Input frequency over the range of device supported	Check frequency of input voltage
Rectifier NPLL	The phase loop of Rectifier not locked	Check input voltage
Input voltage too low	Input voltage lower than lower limit value	Check input voltage
DC bus error	DC bus voltage is abnormal(too low or too high)	Check system parameter
EPO fault	Emergency stop button is pressed	After troubleshooting the system, Popup EPO button
The internal temperature of device too high	The working status of fan is abnormal	Check fan
Input voltage too high	Input voltage higher than upper limit value	Check input voltage
Input current over limit	Input current higher than upper limit value	Check system parameter
Grid voltage too high	Grid voltage higher than upper limit value	Check grid voltage
Feedback current over limit	Feedback current higher than upper limit value	Check system parameter
DC bus too high	DC bus voltage higher than upper limit value	Check DC Bus
Load side IGBT-OC1	IGBT of line L upper bridge arm on load side damaged	Check and replace IGBT
Load side IGBT-OC 2	IGBT of line L lower bridge arm on load side damaged	Check and replace IGBT
Load side IGBT-OC 3	IGBT of line N upper bridge arm on load side damaged	Check and replace IGBT
Load side IGBT-OC 4	IGBT of line N lower bridge arm on load side damaged	Check and replace IGBT
Grid connected side IGBT-OC 1	IGBT of line L upper bridge arm on grid connected side damaged	Check and replace IGBT
Grid connected side IGBT-OC 2	IGBT of line L lower bridge arm on grid connected side damaged	Check and replace IGBT
Grid connected side IGBT-OC 3	IGBT of line N upper bridge arm on grid connected side damaged	Check and replace IGBT
Grid connected side IGBT-OC 4	IGBT of line N lower bridge arm on grid connected side damaged	Check and replace IGBT

8 After-Sales Service

Intepro Systems provides a full range of technical support to customers. Customers are encouraged to contact our branch office or our technical personnel when you have purchased our product.

For the details of warranty, please refer to the terms of warranty. We provide paid customization service packages at different levels, including fast response, preventive maintenance, and warranty renewal service. Please contact the local service centers of our company.

- Service Telephone
  USA: +1.714.953.2686
  UK/Europe: +44.1251.875600
  Asia: +86.755.86500020

- On-line technical service: www.InteproATE.com

- Intepro Systems America, LP
  14712-A Franklin Avenue
  Tustin, CA 92780
  USA
  Tel: +1.714.953.2686
  Fax: +1.714.673.6567

INTEPRO SYSTEMS

Quality

Service

Innovation

Warranty Card

Dear _____,

Thanks for your support and patronage. This card is to ensure that in case the grid simulators you have purchased (model: _____, serial number:_____ fail in normal conditions of use within a year because of the process error or component deterioration, Intepro Systems, LP. will have responsibility to provide after-sales service for free.

Please note:

The machine is required to be installed and used properly. Do not modify the structure, circuit or component.

1. If the machine has faults, please call us or pack the machine properly and indicate the faults before sending back to our company. We will serve you as soon as possible.
2. If the warranty period expires, and the customer keeps the card, we will charge a reasonable fee after the completion of repair.

Attn: _____ Date:_____